

Some Observations Concerning the Third Tone in Latvian\*

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\*Sponsored in part by the National Science Foundation through Grant GN 534.1 from the Office of Science Information Service to the Computer and Information Science Research Center, The Ohio State University.

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Considering the importance of the Baltic languages in the study of Indo-European, it appears surprising that no extensive acoustic phonetic investigation of the suprasegmental systems of Lithuanian and Latvian has been undertaken, although these methods have been available for approximately twenty years.<sup>1</sup> The present

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<sup>1</sup>Both Lithuanian and Latvian have been studied quite extensively by traditional phonetic methods. For one description of Latvian, cf. R. Ekblom, Die lettischen Akzentarten (Uppsala, 1933).

study aims to offer a modest contribution to a very limited aspect of the somewhat neglected question: the acoustic realization of the so-called third tone in Latvian.

Historically, the third tone is a Latvian innovation.<sup>2</sup> It

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<sup>2</sup>For a recent summary of literature dealing with the third tone, cf. Vjač. V. Ivanov, "O preryvistoј intonacii v latyšskom Jazyke", Rakstu krājums. Veltījums Akadēmikim Profesoram Dr. Jānim Endzelīnam viņa 85 dzīves un 65 darba gadu atcerei. LPSR ZA Izd. (Rīga, 1959), pp. 133-148.

appears on certain long syllables; the domain of the tone is a long vowel, diphthong, or sequence of vowel plus resonant. The third tone, whose phonetic nature is hinted at by its German names "Stosston" or "gebrochene Intonation",<sup>3</sup> contrasts in Latvian

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<sup>3</sup>The phonetic character of the tone is described by Ekblom (op. cit., pp. 23 ff.) as involving a steep rise in laryngeal vibrations, followed by an approximation or closure of the vocal folds (the "Stoss"), during which the amplitude of the laryngeal vibrations decreases or the vibration itself disappears. This period, also called "Umbruch" by Ekblom, is followed by a period

of renewed vibrations of the vocal folds, which however vibrate with a decreasing frequency. The tone is elsewhere described by Ekblom as rising-falling.

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with the acute and circumflex tones; the latter two will not be further treated in the present article. Every long syllable has one of the three tones.

The Latvian third tone is frequently compared with the Danish prosodic feature called *stød*. Trubetzkoy, for example, contrasts long syllable nuclei with an interruption between the first and second part of the syllable nucleus with those that have no such interruption.<sup>4</sup> Danish and Latvian serve as illustrations of the

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<sup>4</sup>N. S. Trubetzkoy, Grundzüge der Phonologie (Göttingen, 3rd ed., 1962), p. 173: "Was hier über die Sprachen mit zwei Betonungsarten der langen Silbenträger gesagt worden ist, kann auch in Bezug auf diejenigen Sprachen wiederholt werden, wo die langen Silbenträger den sogenannten "Stoss" (dänisch *stød*) kennen. Ob dieser "Stoss" in einem vollständigen Verschluss der Stimmritze oder nur in einer starken Verengung derselben besteht, ist unwesentlich. Wichtig ist, dass durch diese Artikulation der lange Silbenträger in zwei Teile geteilt ist. Der Umstand, dass in den betreffenden Sprachen die langen Silbenträger in solche mit einer Unterbrechung zwischen Anfangs- und Schlussteil und in solche ohne derartige Unterbrechung zerfallen, während bei den kurzen Silbenträgern dieser Gegensatz nicht besteht, zeigt deutlich, dass das Vorhandensein von Anfang und Ende als zweier gesonderter Momente in diesen Sprachen nur für die langen Silbenträger wesentlich ist. In den Sprachen, die den Gegensatz "mit Stoss - ohne Stoss" bei langen Silbenträgern kennen, erscheint derselbe Gegensatz auch bei Diphthongen und Verbindungen von "Vokal + Sonorlaut", wodurch die Zweigliedrigkeit der langen Silbenträger besonders deutlich erwiesen wird. Zu diesem Typus gehören z.B. das Dänische, das Lettische usw."

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first type.

The notion that the Danish and Latvian prosodic feature (i.e. the *stød* and the third tone, respectively) involves a division of the syllable nucleus into two parts is likewise supported by

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<sup>5</sup>R. Jakobson and M. Halle, Fundamentals of Language (s'Gravenhage, 1956), p. 24: "In the intrasyllabic variety of the stress features, the so-called stosston (stød) feature, two continuous fractions of the stressed phoneme are compared with each other. To an even distribution of loudness throughout the phoneme, another type is opposed: the initial portion of the phoneme presents the peak of loudness, whereas in the final portion the loudness decreases. According to S. Smith's analysis of the Danish stød, the decline of amplitude, often accompanied by a decrease of the fundamental frequency, is due to an abruptly decreasing innervation of the expiratory muscles. A ballistic movement of the expiratory muscles, opposed to a more even movement, produces a similar prosodic feature, e.g. in Latvian, Lithuanian dialects and Livian."

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on the analysis of the Danish stød by S. Smith.<sup>6</sup> However, their

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<sup>6</sup>S. Smith, "Contributions to the solution of problems concerning the Danish stød", Nordisk Tidsskrift for Tale og Stemme, VIII (1944).

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claim that the Latvian third tone is produced by a particular type of ballistic movement of the expiratory muscles is not supported by any references to experimental evidence.

Whatever the physiological mechanisms underlying the production of stød and the third tone, the acoustic outputs obviously have a certain degree of similarity in the two languages.<sup>7</sup> It

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<sup>7</sup>This was claimed, among others, by Ekblom (op. cit., p. 50): "Dieser lettische Akzenttypus stimmt übrigens fast im Detail mit der Form des dänischen Stossakzents überein, über die ich früher berichtet habe."

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appeared to be of interest to look at some acoustic realizations of the Latvian third tone and the Danish stød, and to describe

the possible acoustic similarities that might underlie the perceptual similarity observed by many phoneticians.

In this paper, I will present first some observations regarding the phonetic realization of the third tone in Latvian, and then an informal comparison with phonetic realizations of the stød in Danish.

In the course of a study of suprasegmental features in many languages, I made a recording of 239 Latvian utterances.<sup>8</sup> The

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<sup>8</sup>The Latvian utterances were compiled and produced by Dr. Valdis Zeps, a native speaker of Latvian, and recorded on July 24, 1958, at the Communication Sciences Laboratory of The University of Michigan. I would like to express my gratitude to Dr. Zeps for his contributions to the project.

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utterances were analyzed spectrographically at the University of Michigan, using the two Bell Telephone Laboratories' Model D spectrographs then available at The Communication Sciences Laboratory. Broad-band and narrow-band spectrograms were made of each utterance. Since a considerable number of the sentences were repeated in the course of the recording, the total number of spectrograms was approximately 600. The spectrograms were analyzed at the Linguistic Research Laboratory of The Ohio State University.

The recorded material contained 117 instances of occurrences of the third tone. In most occurrences, the third tone was manifested as a change in the phonation pattern used during the production of the syllable carrying the tone. The syllable nucleus started with normal phonation; the normally phonated part lasted for approximately half of the total duration of the syllable nucleus. This first stage was followed by a second, during which the phonation pattern changed abruptly and markedly. This stage, here called interruption, consisted either of laryngealization.<sup>9</sup>

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<sup>9</sup>I use the term 'laryngealization' to refer both to irregular, slow vibrations of the vocal folds and to biphasic phonation.

However, in this set of data, biphasic phonation occurred very rarely.

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or a glottal stop. The distinction between the two types of realizations does not appear to be categorical: intermediate realizations were also observed, which were characterized by very slow vibration of the vocal folds, reflected on spectrograms as irregularly placed spikes with considerable pauses in between. (Several types of realizations are given in Figure 1, which is described later in the text.) For the purposes of this study, an interruption was called a glottal stop, if it involved a pause with a duration of three centiseconds or more.

The interruption was followed by a third stage, whose mode of phonation varied between regular phonation, laryngealization and voicelessness. The duration of the interruption and the third stage together was approximately as great as that of the regularly phonated first stage.

The observations are summarized in Table I. The first column of Table I gives the syllable nuclei on which the third tone appeared.<sup>10</sup> The second column indicates the number of occurrences

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<sup>10</sup>The phonemic analysis implied by the selection of symbols is that used by Valdis Zeps in the transcription of the 239 utterances that constitute the analyzed corpus.

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of each syllable nucleus under the third tone in the test sentences. The next column gives the average duration, in centiseconds, of the syllable nucleus.<sup>11</sup> The next three columns give the average

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<sup>11</sup>These averages are somewhat smaller than those given by Ekblom (op. cit., pp. 10ff.). A possible reason is the fact that all Ekblom's test words were produced in isolation.

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durations of the three stages described above, here symbolized as  $V_1$ , Interruption, and  $V_2$ . For long monophthongs,  $V_1$  and  $V_2$  are

two stages of the same vowel; for diphthongs and vowel + resonant sequences,  $V_2$  is either the second component of the diphthong or the resonant.<sup>12</sup>

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<sup>12</sup>Spectrographic analysis made it possible to localize the placement of the interruption: in diphthongs it occurred during the transition from the first to the second component of the diphthong, in vowel + resonant sequences between the vowel and the onset of the resonant.

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The next three columns tabulate the number of times the interruption was realized as glottal stop or laryngealization.<sup>13</sup>

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<sup>13</sup>There were nine instances in which no interruption was observed. In six of these, the second part of the syllable nucleus was either completely laryngealized or voiceless; in one case, the whole syllable nucleus was laryngealized (the word occurred in sentence-final position). In two productions of the word [aizraʔavaʔas] (likewise in sentence-final position), the first and second syllable were produced with no apparent modification of the phonatory pattern; the final syllable contained a clearly manifested glottal stop.

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It may be noted that the number of glottal stops (i.e. interruptions of 3 csec or longer) was slightly greater than the number of laryngealized realizations. The last three columns give the number of instances the second component of the syllable nucleus (i.e. the third stage) was normally phonated, laryngealized, or voiceless.

Table II presents the information contained in the last three columns of Table I in a different way. There appeared to be some regularities connected with the position of the word, on which the third tone appeared, within the larger utterance of which it constituted a part. These regularities become obvious in Table II, which shows the realization of the second component of the syllable nucleus bearing the third tone, expressed as a function of the position of the word in the sentence. In isolated words, all realizations occurred;  $V_2$  was voiced approximately as frequently

as it was voiceless. If the word with the third tone was initial in its utterance, voicing and laryngealization predominated. Voiced realizations were relatively most frequent when the word occurred in medial position. In final position, the voiceless realizations were most numerous.

The study of fundamental frequency gave less clear results. Due to the presence of laryngealization, the narrow-band filter of the spectrograph failed to resolve the acoustic signal into clearly identifiable harmonics. In those parts of the utterances that could be analyzed, it became clear that the direction of fundamental frequency movement played no part in the realization of the third tone by this speaker.

Some illustrations of the various realizations of the third tone are offered on Figure 1. This figure contains reproductions of broad-band spectrograms of seven utterances by speaker V.Z. The first row shows an isolated production of the word [laʔatʃi] "bears"<sup>14</sup> and the same word in final position in the sentence

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<sup>14</sup>Phonetic spellings and glosses by Valdis Zeps.

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[tʃigaːni danˈtsina laʔatʃus] "The gypsies make bears dance". In the isolated production, the interruption was realized as laryngealization; the third stage was phonated. In the sentence the interruption was produced as glottal stop, while the third stage was voiceless.

The second row contains an isolated production of the word [muʔʌcis] "a stupid person or thing" and the sentence [tʃɛlə [malaʔa gul ʌuntʃs muʔʌcis] "An evil idiot lies at the side of the road". In the isolated production, the interruption was manifested as a glottal stop; the resonant was voiceless. The same realization occurred in the sentence. (Note also the realization of the third tone on the second syllable of [malaʔa], with three clearly distinguishable stages and regular phonation of the third stage.)



The third row contains an isolated production of [saʔap] "hurts" and two productions of the utterance [man gaʔiva saʔap] "I have a headache". The third tone was realized as a glottal stop in the isolated production, followed by a voiceless third stage. The glottal stop and a short voiceless stage were also present in the two sentences. The first stage of this syllable nucleus was laryngealized in both productions, probably under the influence of the falling terminal intonation. (Note also the realizations of the third tone as a brief period of laryngealization during the transition from the vowel to the resonant in both productions of [gaʔkva].)

To recapitulate, the feature associated with more than 90% of the productions of the third tone was the change in the mode of phonation approximately in the middle of the syllable nucleus. This change was also the only constant feature. It was apparently not important whether it was realized as laryngealization or as a glottal stop. The direction of the fundamental frequency movement before and/or after the interruption appeared to be subject to the overriding influence of sentence intonation. The varying realizations of the period following the interruption seemed to depend on the position of the word within the sentence.

A considerable amount of work has been done in the analysis of the Danish stød.<sup>15</sup> However, most of the material published up

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<sup>15</sup>Cf. S. Smith, Stødet in dansk rigssprog (København, 1944), and K. Ringgaard, Vestjysk stød (Aarhus, 1960).

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to now is not directly comparable to the Latvian material described above. Therefore I selected some Danish materials available to me and analyzed them in the same manner.<sup>16</sup>

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<sup>16</sup>The Danish materials consisted of a set of monosyllabic words and disyllabic compounds. The syllable nuclei containing the stød feature were similar to the Latvian syllables with the

third tone, consisting mostly of sequences of vowel + resonant. The words (some of which are quoted in Danish orthography) were selected by Mr. Jørgen Rischel, a native speaker of Danish, who recorded the list of words on January 29, 1962. The spectrographic processing of the recording was carried out in the Communication Sciences Laboratory of the University of Michigan; the spectrograms were analyzed at the Linguistic Research Laboratory of the Ohio State University. I would like to express my appreciation to Dr. Rischel for his contribution.

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The analyzed set of words contained 118 items with *stød*. A much greater variety of realizations was observed in the Danish words than in the production of the 117 Latvian words analyzed previously. In 8 cases, the total vocalic part of a vowel + resonant sequence was laryngealized. There were 13 cases in which the realization was similar to the prevalent Latvian pattern: a period of laryngealization inserted between the vowel and the resonant. By far the greatest number of realizations, 59 out of 118, consisted of sequences in which the vowel was normally phonated, the resonant laryngealized. There were three cases in which the laryngealization set in after the resonant had already been articulated; no such cases occurred in Latvian.

In the few test words in which the vowel was followed by an obstruent, the syllable nucleus consisted of a phonated first part and a laryngealized second part in 13 instances; a three-stage realization was observed in only 9 instances.

Figure 2 illustrates some realizations of *stød*. The figure contains broad-band spectrograms of six utterances produced by speaker J.R. The first row shows isolated productions of the monosyllabic words ring "circle" and vej "way" and the disyllabic compound ringvej "circular way". In ring, the *stød* was manifested as laryngealization of the second part of the complex syllable nucleus. In ringvej, the *stød* (appearing only on the second member of the compound) was manifested as gradual laryngealization of the whole syllable nucleus, with devoicing of its terminal part.

The second row contains isolated productions of the words fod "foot" and sål "sole" and the compound fodsål "sole of the foot".

In fod, stød appeared as a brief period of laryngealization at the transition from the vowel to the consonant. In the word sål, stød was realized in a similar way and the final resonant was fully voiced. In the compound fodsål, the stød appearing on the second member of the compound was realized as strong laryngealization of the second part of the vowel, encompassing also the final resonant, which was gradually devoiced.

The question is now whether the similarities or the differences between the realizations of the two prosodic features are more significant. Cross-language identification of phonological features is a question of high theoretical interest; however, it is a question that cannot be answered by techniques of acoustic phonetics. Until the two features have been found to contrast in some language, one is inclined to agree with Trubetzkoy that the phonetic details are irrelevant, as long as the first part of the syllable nucleus is contrasted with the second part. The fact that the Latvian third tone consists of three clearly identifiable stages, while the Danish stød generally consists of two stages, need not contradict this view. However, if a phonetic description of the realization of the feature is offered at all, it might as well be as close to observable facts as possible.

Table I

Realizations of the third tone on long vowels, diphthongs, and vowel + resonant sequences  
in Latvian.

Syllable nucleus	Number of occurrences	Average duration in csec	Average duration of			Number of instances of interruption being			Number of instances of V <sub>2</sub> being		
			V <sub>1</sub>	Inter- ruption	V <sub>2</sub>	glottal stop	lar.	absent	Voiced	Lar.	Voiceless
i	14	16.6	7.7	4.4	4.5	9	4	1	1	5	7
e	13	19.2	8.7	5.2	5.3	5	6	2	6	3	2
æ	7	19.8	10.3	5.6	3.9	2	5	-	5	2	-
a	27	17.4	7.8	4.6	5.0	15	9	3	6	3	15
u	8	15.5	6.4	4.0	5.1	3	5	-	4	1	3
ei	4	15.0	6.5	5.0	3.5	2	-	2	-	1	1
ai	3	18.0	8.0	4.0	6.0	1	2	-	1	1	1
au	6	20.7	11.2	5.2	4.3	4	2	-	3	2	1
ia	12	14.8	7.0	4.2	3.6	5	7	-	6	3	3
ua	4	18.3	8.3	4.7	5.3	2	1	1	1	-	2
æɫ	8	19.7	9.9	6.3	3.5	7	1	-	1	3	4
al	4	20.1	11.0	4.8	4.3	-	4	-	3	1	-
ul	5	17.8	7.4	5.4	4.0	4	1	-	1	-	4
ir	1	15.0	9.0	4.0	2.0	1	-	-	1	-	-
ær	1	20.0	13.0	3.0	4.0	1	-	-	1	-	-
Totals and Averages	117	17.8	8.8	4.7	4.3	61	47	9	40	25	43

Table II

The realization of the second component of the syllable nucleus bearing the third tone, expressed as a function of the position of the word in the sentence. The numbers in the cells indicate numbers of occurrences.

Position/ Realization	Voiced	Laryngealized	Voiceless	Absent	Total
Isolated	17	5	19	4	45
Initial	5	6	2	-	13
Medial	13	6	1	1	21
Final	5	8	21	4	38
Total	40	25	43	9	117

### Figure Legends

Figure 1. Broad-band spectrograms of seven Latvian utterances,  
produced by informant V.Z.

Figure 2. Broad-band spectrograms of six Danish utterances,  
produced by informant J.R.

0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8



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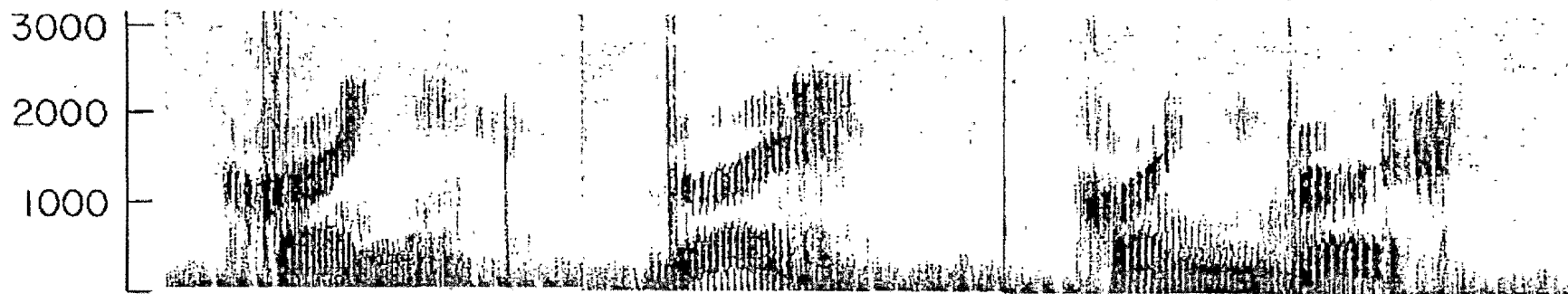


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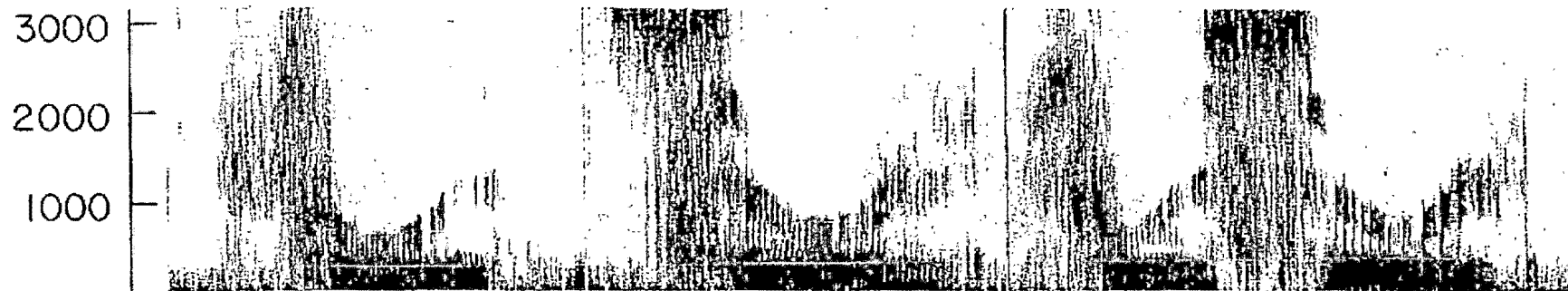
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